

Report of the Tevatron BPM Instrumentation Upgrade Technical Review Committee

Review Committee

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The review took place on December 16, 2004. The Tevatron BPM system and the need for the upgrade are described in [1] and will not be repeated here.

Committee Charge

1. Is the technology choice appropriate and adequate to meet the approved requirements/needs of Run II?
2. Is the technology choice the most cost/time effective solution for the required performance? Consideration should be given in particular to the development time involved, the schedule and long-term maintenance of the system. The goal for the project is to complete the BPM upgrade by October 1, 2004.
3. The highlights of the requirements include (a) supporting an order of magnitude improvement in position resolution and (b) making signals from both protons and anti-protons available. Please comment specifically on the capabilities of the chosen technology with regards to these requirements.
4. Review the key specification parameters for the hardware choice and the technical plan for the project.
5. Review and comment on the plans for the associated software items.
6. Comment on the cost and schedule and allocated resources - do the estimates appear reasonable?

Response to the Charge

1. Except for the simultaneous measurement of closed orbits for protons and pbars, we believe that the proposed technology choice of using digital under sampling followed by digital down conversion will meet the approved requirements. Not enough information was presented in the review to determine the accuracy of the closed orbit measurements during a store. Some members of the committee felt that the absolute measurement by the proposed method would not work but that relative beam motion during a store might be measured to the required accuracy.
2. The Echotek board appears to be the lowest risk path to delivering a working system by October 1, 2004. The schedule constraint rules out other promising hardware such as the damper boards
3. The chosen method (which we call narrow band) has several advantages (reduced dynamic range, modest timing resolution) and it should be able to make measurements to the required accuracy when there is only one type of particle in

the Tevatron. However, since the system has reduced time accuracy (which is a fundamental limitation in a narrow band system) it is very difficult to separate signals that are closely spaced in time. Thus, separating the proton from the pbar signal has to be done by another method. The method chosen was based on the assumption that all the front end components were linear time invariant devices. To first order this is true but there are small nonlinearities in many of the components which may make it impossible to reach the 7 micron required position accuracy. In particular, the position measurement may be sensitive to the beam position in the non measured coordinate (that is, the position measurement in a horizontal BPM may have a small dependence on the vertical position). Also, the magnitude of the correction shown at the review was large compared to the required accuracy so that a very careful calibration of every BPM is likely to be required. No data was presented on the construction and installation tolerances for the beam pickups. These errors could determine the overall precision that can be achieved.

A wideband system such as the one used at RHIC could probably make all the required measurements but it would require an adjustable gain amplifier to handle the dynamic range and a very accurate timing system to make the measurements. Given the tight schedule constraints, the committee recommends that the narrow band option be pursued. However, if it is feasible, we recommend that a connection point be provided at some of the BPMs so that a wide band system could be installed at a later time. This system would be used to make the closed orbit measurements.

The Beam Loss Monitor system seems to be a simple system that can be easily accommodated in the new design.

4. This item is covered in item 3 above.
5. No software plan was presented.
6. We did not do an extensive review of the cost since most of the cost is for a commercial product. The schedule is very aggressive but can probably be met. The recycler BPM system was built in on a similar schedule. The committee feels that it is essential that a way be found to operate the new system in parallel with the old or convert only a few BPM's so that a lot of operational experience can be gained before making the conversion to the new system. Since most of the hardware is commercial, the manpower profiles should be adequate. We are concerned that there is no one identified as a technical manager who would serve as a system 'integrator'. The project is drawing people from 2 laboratory divisions and someone who can closely coordinate the work is needed.

Meeting the October 1, 2004 date is a management challenge. If this date is to be made, it is very important that key personnel not have any other responsibilities.

Recommendations.

1. The BPM group should move as quickly as possible to install a single complete BPM system using the existing Echotek boards. This system should be running before the next DOE review in February. Release of the purchase order for the Echotek boards should be contingent on the successful demonstration of this system.
2. Allow the option for a second signal path so that some subset of the BPMS could make additional wide band (time domain) measurements of the closed orbit positions
3. There should be a person designated as a system integrator. This person should not have any other major responsibilities.
4. Commissioning appears to be in the very early planning stages. Installing this system without disrupting Tevatron operations is likely to require very careful planning. We recommend that a commissioning and installation plan be developed as soon as possible in consultation with the Tevatron and Accelerator Integration departments.

Additional Comments.

Several members of the committee felt that reliable and consistent performance was the most important project goal and that delivering a good system by October 1, 2004 was more important than delivering a great system at a later date. Also, missing the fall 2004 shutdown will almost certainly introduce a significant delay in the project.

References

- [1] A. Baumbaugh, M. Church, D. Edwards, M. Harrison, J. Marriner, D. McGinnis, M. Syphers, *Review of Tevatron BPM Requirements Document*, September 2003